Focus

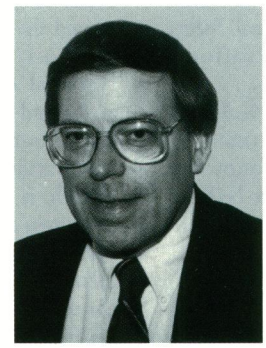
Downstream in America

In the 1960s, children used to sit on the banks of polluted rivers, tossing matches into the water, watching joyfully as the surface ignited. In 1968, Americans didn't find it so amusing when the Cuyahoga River in Ohio burst into flames because it contained so much oily waste and pollution.

The Cuyahoga drew national attention to the problem of water pollution. Most of this pollution accumulated after World War II, when the United States experienced a massive increase in the generation of industrial waste. Thousands of new synthetic organic chemicals were being manufactured, and pollutants were increasingly discharged into the environment. Industrial facilities were often built on the banks of rivers and lakes so that they could dump waste chemicals into the water.

As Americans watched their water, air, and land deteriorate, it became obvious that action needed to be taken. Rachel Carson's *Silent Spring,* a bestseller that alerted the nation to the pending dangers of the careless use of pesticides, became an impetus for grass roots environmental movements. Groups began lobbying the federal government to address environmental problems. In response to these issues, the U.S. Environmental Protection Agency was created by executive order in 1970 from 15 preexisting units. Some of the EPA's earliest actions were enacting major pieces of legislation dealing with air and water pollution.

Since the creation of the EPA, over the last 20 years, the levels of many toxins in freshwater sources have dropped significantly, but exactly how much the levels have dropped is difficult to pinpoint. Much of the progress in reducing water pollution can be attributed to the Clean Water Act and the Safe Drinking Water Act. Both acts were passed in response to increasingly poor water conditions. The CWA was originally the Federal Water Pollution Act of 1948, but after the creation of the EPA, it was totally revised with amendments in 1972, creating a system of standards, permits, and enforcement for dischargers of industrial and municipal effluent. The objective was to restore and maintain the "chemical, physical, and biological integrity of the nation's waters." The major goals of the act are fishable, swimmable rivers and lakes and the total elimination of pollutant discharges into navigable waterways. Congress has since fine-tuned the act in 1977, 1981, and 1987 and is currently debating its reauthorization.



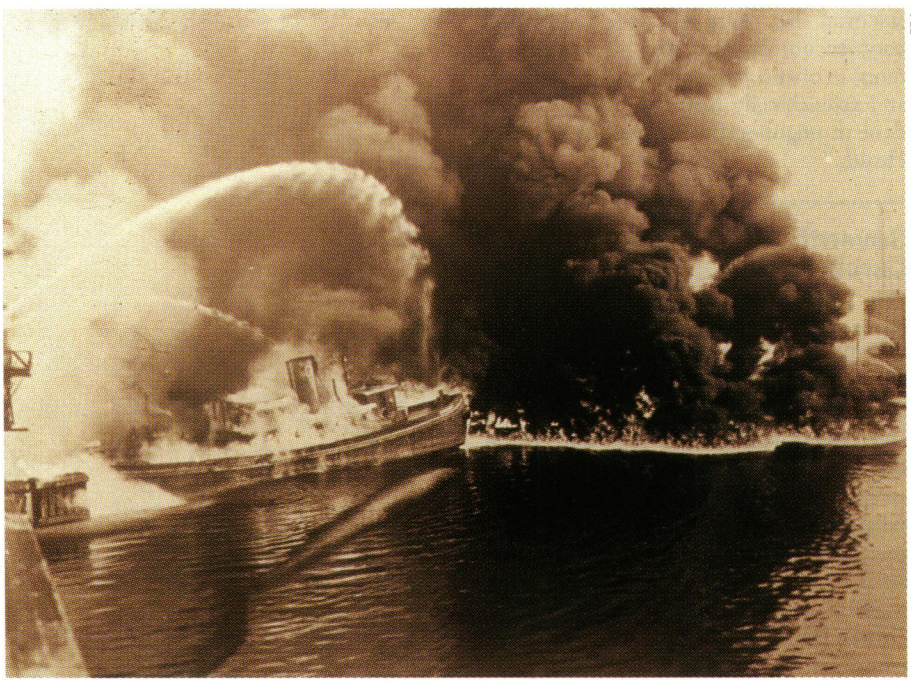
Michigan Dept. of Public Health

Harold Humphrey—Fish have the highest dose per bite of environmental toxicants.

The SDWA was passed in 1974 and amended in 1977, establishing national standards for drinking water from surface and underground sources. The EPA provides maximum contaminant levels for pollutants in drinking water, enforced by the states. The SDWA was passed in reaction to epidemics of waterborne diseases such as cholera, typhoid, dysentery, and infectious hepatitis. Due to methods of water purification, these outbreaks have been drastically reduced.

These acts have led to significant progress in improving water quality in the United States. Yet the problems haven't been eliminated. Just last year there was a major outbreak in Milwaukee of cryptosporidia, a microorganism that causes incapacitating diarrhea in humans. And new problems have arisen with water contamination, of which long-term human health effects are uncertain. There is growing concern over pollutants in the water including inorganic chemicals such as nitrate, arsenic, and lead; toxic organic chemicals such as DDT and PCBs; and some pesticides. The EPA recently reported that 40% of America's rivers and lakes are not suitable for fishing and swimming, far from the goal of the CWA.

With both the CWA and SDWA up for reauthorization this year by Congress, the quality of America's water bodies is being scrutinized by groups such as environmentalists, industry, and government. Bills to reauthorize and strengthen the CWA are currently being reviewed in both the House and the Senate. House Public Works and Transportation Committee Chair Norman Mineta (D-California) has introduced HR 3948, and the Senate Environment and Public Works Committee has reported Chair Max Baucus's (D-Montana) bill, S 1114. Both of these bills aim to widen the powers of the EPA, expand the focus of federal water policy from individual sources of pollution to comprehensive, watershed-wide planning, and begin to address land-use policy. Opposition to these bills has come from state officials, who say the bills would impose unfunded federal mandates and complicate ongoing state efforts on nonpoint-source pollution and watershed pro-



EPA

River of fire. The burning of the Cuyahoga River in Ohio because of chemical contamination ignited a movement for clean water.

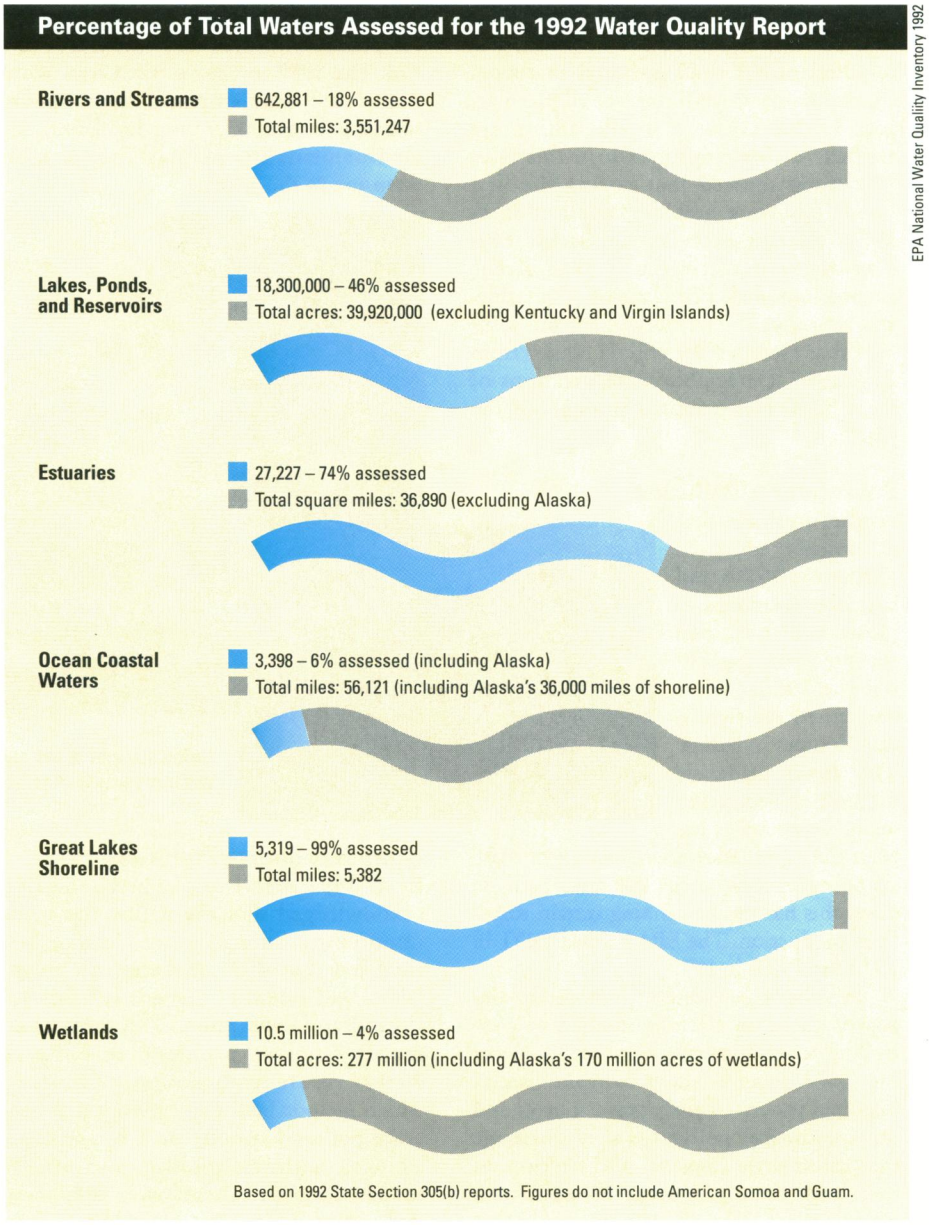
tection. The EPA is now working with states to reach compromises on these issues, attempting to pass a reauthorization of the CWA this year.

Lower Levels

Assessing national water quality has been difficult due to a lack of national data on toxic contaminants. Tracking water quality state by state has been made possible by the requirements of the Clean Water Act. However, it is an expensive and tedious procedure, and because the methods of each state are not uniform, the data are inconsistent. States report their water assessment under Section 305 B of the CWA, and the assessments are compiled in an EPA biennial report to Congress, entitled the National Water Quality Inventory. Yet the information is not conclusive for a nationwide assessment because states do not monitor all of their waters. In the EPA's most recent report to Congress, only about 18% of the nation's rivers and lakes were assessed. "It's hard to draw a national summary, based on the fact that we only have information on waters that are assessed," said Barry Burgan, a spokesperson for the EPA. Some scientists say that it is impossible to summarize national water-quality conditions and trends from state reporting of water quality. The EPA is currently working on a long-term study that aims to show statistically significant trends in national water quality. The EPA's Monitoring and Assessment Program represents areas not usually monitored, by assessing randomly selected rivers, lakes, and streams around the country. The program was begun about five years ago, but it has not yet produced any conclusive data.

The lack of data on national water quality has also made it difficult to track the levels of specific chemicals in America's waters. For the 1992 National Water Quality Inventory, the EPA requested that states track the extent of toxic contamination in their surface waters. Forty-eight states responded, but only small percentages of waters were monitored. From the figures each state submitted, the EPA estimated that 43% of America's lakes contain toxic contamination, while only 8% of the sampled rivers do. The EPA points out that the figures do not reveal the extent of toxic contamination in all waters because most toxic pollutants are found in the sediment and food chain, not in the water column.

Exceptions to the lack of national data are two studies that monitored national water quality over time. The first study indicated that the levels of toxins in the nation's waters have been dropping. The second study showed that contaminants from nonpoint-source pollution continue to pose a problem in water quality.



A drop in the bucket. A lack of national water assessments makes it difficult to get a clear picture of America's water quality.

In the first study, the U.S. Fish and Wildlife Service collected fish from streams around the nation and analyzed their tissues for concentrations of several trace elements. Toxic concentrations in finfish tissue are indicative of water quality and can reflect long-term average contaminant concentrations. Two species of fish were collected at each station, one bottom feeding and one predator species. Four toxic elements, arsenic, cadmium, lead, and mercury, were measured from 1976 to 1986, three of which showed decreases in concentrations. Arsenic, cadmium, and lead decreased from 50 to 63%, while mercury remained constant. Organic compounds were also measured, including DDT and related compounds, dieldrin, and total PCBs. All of these decreased by more than 60% between 1970 and 1986. Concentrations of toxaphene, a chlorinated compound used as an insecticide, decreased by 65%, and chlordane and related compounds decreased by 32% between 1976 and 1986.

A second contributor to national information on trends in water quality was a study conducted from 1989 to 1991, published in the October 1991 issue of *Environmental Science and Technology*, that examined the magnitude and distribution of herbicides in streams. In the 1970s, use of herbicides before crops and weeds start to grow (preemergent) increased rapidly, reflecting changes in agricultural practice. Although this study, which examined the presence of herbicides in a random sample

of 149 streams draining agricultural basins in a 10-state region of the Midwest, was regional rather than national in scope, approximately three-fourths of all preemergent herbicides used in the nation are applied to row crops grown in this area. The study showed that during the first runoff following herbicide application in 1989, atrazine exceeded applicable EPA drinking-water criteria in 52% of the streams sampled. For alachlor, cyanazine, and simazine, the number of streams sampled that exceeded the criteria ranged from 2 to 49%. Detectable concentrations of these herbicides persisted throughout the year.

Point-Source Pollution

Studies indicate that water quality improved during the 1970s and has either continued to improve or remained about the same throughout the 1980s. What has caused the significant declines in toxins? The most effective method of decreasing toxins in the water has been the elimination or reduction of toxic dumping into water. In the most extreme cases, this has meant banning certain toxins from production. The EPA banned DDT in 1972 and PCBs in 1977.

In other cases, careful monitoring has proven to be an effective method of controlling toxic dumping. Section 304(1) of the CWA requires states to make lists of impaired waters, identify point sources and the amounts of pollutants they discharge that cause toxic impacts, and develop an individual control strategy for each such point source. The most common point sources, single, identifiable sources of pollution, are industrial facilities, municipal treatment plants, and combined sewer overflows. The EPA and states have established tough permit conditions aimed at controlling point-source discharges. They work together to issue permits, conduct compliance inspections, monitor activities, and enforce compliance. For the most part, point sources have been cooperative, with high percentages of compliance. About 10% of municipalities are in significant noncompliance with permit conditions, and about 7% of industrial facilities are in noncompliance. The decline of many toxins in water have been attributed to this targeting of point-source pollution.

Today, less than 15% of water pollution can be traced to point sources. Yet there continues to be a persistent problem with nonpoint-source pollution. Because of the difficulty in identifying, isolating, and controlling nonpoint sources, the EPA has primarily focused on point-source control. The 1987 revision of the Clean Water Act placed more emphasis on nonpoint-source pollution than prior legislation, but environmentalists are pushing for more attention to this issue.

Sierra Club

Nonpoint-source Pollution

Going straight to the source. Proposed regulations for cleaner rivers and lakes will force attention to both direct and indirect sources of pollution.

Nonpoint-Source Pollution

In its 1992 report to Congress, the EPA acknowledged that the nation has made important strides in water cleanup, but reported that 40% of America's rivers, lakes, and estuaries are not suitable for fishing and swimming. The most commonly reported problems in polluted waters result from nonpoint sources, which include land use activities that generate polluted runoff, such as construction, agriculture, mining, and on-site sewage disposal; contaminated sediments; and atmospheric deposition (the transfer of pollutants in the air to water through precipitation or other means). Major pollutants include siltation, pathogens, pesticides, herbicides, and metals such as mercury, lead, and cadmium. Nutrients, including nitrates found in sewage and fertilizers and phosphates found in detergents and fertilizers, are also major pollutants. In excess levels, these nutrients overstimulate the growth of aquatic plants and algae, which can clog navigable waters, thus affecting the respiration of fish and affecting use of the water for fishing, swimming, and boating. The leading source of water pollution for both rivers and lakes is agriculture. Siltation and nutrients are the major pollutants of rivers, while metals and nutrients are the major pollutants found in lakes.

In 1987, Congress enacted Section 319 of the CWA, which established a national program to control nonpoint-source water pollution. It mandated that states were to address this issue by developing nonpoint-source assessment reports, adopting management programs, and implementing the programs over several years, with federal approval and assistance. The EPA plans to update strategies in dealing with nonpoint-source pollution this year. Environmentalists are pushing Congress to make changes to the CWA that would put more emphasis on controlling nonpoint-source pollution. Their proposals include mandatory controls that require landowners to prevent runoff. "Every landowner, especially in an impaired watershed, needs to do something," said Robyn Roberts, coordinator of the Clean Water Network, a coalition of about 500 citizens' organizations campaigning to strengthen the CWA. Roberts said the types of runoff prevention activities they are proposing range from hi-tech to low-tech. The mandates would be monitored by state and local governments, not by citizens. Speaking for environmentalists in general, Roberts said, "We're not trying to take individual farmers to court."

Several local and regional programs have been developed to help correct the problems of nonpoint-source runoff. It is difficult to coordinate national programs because it is such a pervasive problem. An example of a regional program is the joint effort of the U.S. Fish and Wildlife Service and The Nature Conservancy in a stream

bank restoration program in Virginia. The program, aimed at reducing agricultural runoff into rivers, pays farmers to build fences to keep their cattle out of the rivers, establish alternative water sources for cattle, and restore stream banks.

Sierra Club

The Great Lakes

The Great Lakes offer a model for identifying trends in the effects of water pollution because most contaminants that enter this contained water system remain there indefinitely. Because they are contained, it is easier to assess a majority of the waters. In EPA's 1992 National Water Quality Inventory, 99% of the Great Lakes were assessed. The lakes, which make up one-fifth of the world's fresh surface water, have been plagued with pollution associated with the large cities on their shores. The major pollutants found in the Great Lakes are toxic organic chemicals, mainly PCBs and DDTs, often found in fish tissues. The Great Lakes serve as a model for atmospheric deposition, an issue the EPA is currently focusing on. Atmospheric deposition accounts for 50% of the pollution of the Great Lakes, while contaminated sediments, land disposal, urban runoff, and sewer overflows are also major sources of pollution.

Over the last 20 years, the United States and Canada have worked together to reduce pollution problems in the Great Lakes. The Great Lakes Water Quality Agreement was signed in 1972 by the governments of both countries, with the goal of restoring and protecting the lakes. The International Joint Commission was formed to monitor and assess progress made by the governments toward the goals of the agreement. The Commission produces a biennial report providing information on Great Lakes water quality.

The two countries have been successful in reducing nutrient-enrichment problems that led to algal blooms, fish kills, and "dead" zones depleted of oxygen, visible in the 1960s. For example, the annual phosphorus load into the Great Lakes has been cut in half since 1970 due to programs such as phosphorous detergent restrictions, municipal sewage treatment plant construction and upgrades, and agricultural practices that reduce runoff.

Today's problems, however, are not as blatant as the dramatic events in the 1960s. Toxic contamination is the most prevalent problem in the Great Lakes. The eight states bordering the lakes have issued advisories to restrict consumption of fish from the lakes because concentrations of mercury, PCBs, pesticides, and dioxins in the fish tissues exceed human health standards. Some of the adverse health effects that have been linked to these pollutants are birth defects, cancer, neurological disorders, and kidney ailments. Although chemical levels have declined significantly, the potential for health effects may remain. For example, research shows that although the concentrations of PCBs in Lake Michigan trout declined by about 90% since 1970, PCBs are still 180 times the target goal of 0.014 parts per million. The International Joint Commission pursues goals of zero discharge and virtual elimination of all persistent toxic substances.

Human Health Effects

The levels of toxins in rivers and lakes have dropped significantly, but are humans really safer? Individual studies have been conducted, but there are yet to be solid, general conclusions. "One fact is that humans accumulate chemical contaminants, but what the effects of those are on humans remains a controversial and unsettled scientific question," said Harold Humphrey of the Health Risk Assessment Division of the Michigan Department of Health.

Humans can be exposed to chemicals through inhalation and other means, but the primary route of exposure is through eating contaminated food. Fish, which store chemicals such as PCBs and DDTs in their skin and fat, have the highest "dose per bite," Humphrey said. Therefore, many studies have concentrated on the effects of Great Lakes fish consumption.

Humphrey pointed out that scientists examining human health effects are focusing on metabolism, neurological impacts, reproductive outcomes, and chronic diseases. No specific conclusions have been made, although individual studies in each area point to possible outcomes. There is also a lack of epidemiological data that show trends, so it is difficult to make generalizations about the effects of chemical contaminants in water on human health over time.

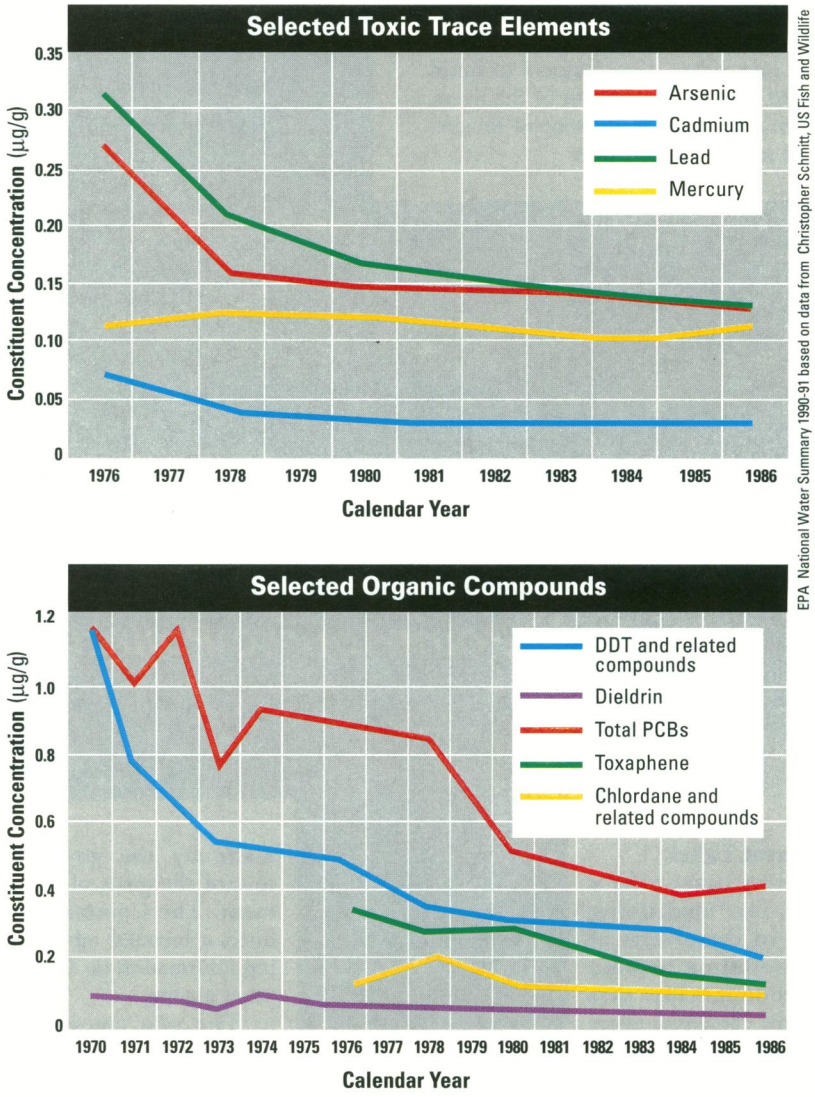
Fisheaters living near the Great Lakes have been subjects for several studies. One such study, conducted in 1989 by Mary Hovinga and colleagues at the School of Public Health of the University of Alabama at Birmingham, reexamined a group of 115 fisheaters and 95 non-fisheating controls that had been examined in 1982 by the Michigan Department of Public Health to evaluate changes in serum PCB and DDT levels. Hovinga's group looked at whether the levels of these toxins in fisheaters and non-fisheating control subjects had decreased over time in humans, as they had in the environment. Contaminant levels were monitored in human tissue, blood, and breast milk. The results showed that DDT levels had decreased in both fisheaters and controls over this time period, but PCB levels showed only a slight decrease in fisheaters only. "We speculated that DDT levels declined because DDT had been banned, and environmental levels had

decreased dramatically," Hovinga said. "But with PCBS, although they have been banned, we haven't had an abrupt stoppage of their use in the industrial cycle. There are still a lot of PCBs in a reservoir for environmental contamination." Hovinga also suggested that PCBs may not break down as quickly as DDT. "It's going to take quite a while for PCB levels to decline," she said.

Human health studies such as Hovinga's confirm that some toxins have decreased, yet others persist. Although PCBs have been banned, they continue to linger in significant amounts in humans. Studies have linked PCBs to reproductive and neurological problems. The area of neurological effects related to toxic exposure is one of the most lively research topics right now, Humphrey said, citing many ongoing studies in this area. In 1989, Michigan held a workshop to discuss what studies were needed to examine human health effects of organohalogen exposure. Four studies evaluating reproductive outcomes after exposure to PCBs were cited at the conference. The studies, conducted in Japan, Taiwan, Michigan, and North Carolina, were not identical or exactly comparable, but tended to link *in utero* exposure to neurological deficits. Humphrey said that most studies evaluating reproductive outcomes after toxic exposure (usually involving mercury and PCBs) do not show fertility problems. Instead, they show birth defects in offspring such as missing limbs. However, no definitive link has been found between chemical exposures and these effects.

Some studies indicate that infertility is a result of toxic exposure. The International Joint Commission cited in its 1994 report on Great Lakes water quality that the effects of toxic substances are not found only in females. Several studies have shown increased infertility, cancers, and other abnormalities in male reproductive systems. It has been reported that human sperm counts have decreased by 50% over the past 50 years. In a recent Canadian study, sperm samples indicated the presence of several organochlorine substances.

The concentration of studies on toxic exposures in and around the Great Lakes does not necessarily mean that residents of this region are at a higher risk of toxic exposure than residents elsewhere in the United States. Several studies have been done to compare the amounts of pollutants among different regions of the country. In 1990, Linda Phillips, now a senior environmental scientist at Versar, Inc., and Geoffrey Birchard, a professor of biology at George Mason University in Fairfax, Virginia, conducted a study using data from EPA's STORET database to compare levels of 24 toxic substances in fish tissue and sediment from around the country. The results



Wet weights. Concentrations of toxicants in finfish tissue reflect a trend toward cleaner water, but many say it's still not clean enough.

showed that the potential for toxics in the Great Lakes is not higher than other geographic regions. "Overall, we found that the Great Lakes region didn't appear to be significantly higher for those pollutants that we looked at compared to other regions," Phillips said. However, there may be "hot spots," or areas in the Great Lakes regions with particularly high levels of toxins that were not included in an analysis of the whole region, Phillips said. Residents of these areas would be more prone to high levels of toxic exposure. Humphrey points out that humans may have passed the time of greatest exposures because today the levels are lower.

The Costs of Clean Water

Cleaning America's water has not been cheap. The EPA estimates that since the first major revision of the law in 1972, the United States has spent nearly $590 billion (in 1990 dollars) on water pollution control. According to the EPA, the costs for water-quality controls, both point-source programs and nonpoint-source programs, make up the largest percentage of water pollution control expenditures. For example, the EPA estimates that water-quality control accounted for 91% of the costs in 1987. Expenditures on point-source pollution are much higher than those on nonpoint-source pollution because of the focus of the CWA on point-source pollution. The majority of these point-source control costs have been for sewage services and wastewater treatment and for control of industrial effluents and the pretreatment of wastewater discharges to municipal treatment facilities.

Annual water pollution costs have increased steadily over time, from about $9.9 billion in 1972 to about $40.5 billion in 1990 (in constant 1986 dollars). By the year 2000, the EPA estimates that costs will reach $60 billion. This increase includes expected costs for additional drinking water

regulations and the need for construction of backlogged municipal wastewater treatment facilities. In addition, more expenditures are anticipated for nonpoint-source pollution control, but the magnitude is uncertain.

Of these totals, the federal government spends about $2 billion each year on water pollution control. The EPA estimates that an additional $7–$10 billion is needed each year through 2010 to meet safe drinking water needs. The difference will be made up by state and local governments, individual taxpayers, and water consumers. Rather than continuing to place much of the cost burden on taxpayers, environmentalists are pushing for legislation that requires industry to pay more for cleanup. A "polluter pays" bill has been introduced by Congressman Gerry Studds (D-Massachusetts) that would raise an additional $4 billion a year in assistance for local water quality improvement. The bill would require per-ton fees on toxic waste discharges, with higher fees for more toxic pollutants, taxes on chemical pesticides and fertilizers, and fees on the largest industrial and commercial water users, to encourage more efficient water use. "Why should the victims of pollution be forced to pay more and more to clean up the mess?" said Clean Water Action President David Zwick, in *Clean Water Action News.* "We believe it's time to make the polluters pay."

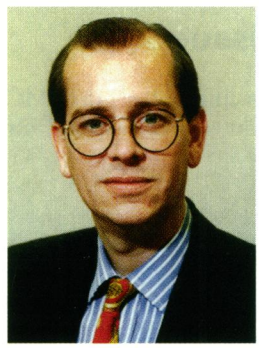
Spokespersons for industry, however, say they are spending enough on water-quality improvement. "We do not support the Studds bill. It sounds good, but basically his proposal is nothing but a tax," said Charles Ingram, a spokesman for the Clean Water Industry Coalition (CWIC). "Business and industry are already spending billions of dollars a year to comply with environmental statutes." Some argue, however, that the amount industry spends each year to comply with environmental regulations pales in comparison to the costs of health care for diseases and other adverse health effects directly and indirectly related to pollution of America's waters.

The Clean Water Controversy

On seemingly opposite sides of the clean water issue are environmentalists and industry. Neither side disputes that progress has been made in the last 20 years; America's rivers and lakes are cleaner than they were when the EPA began focusing on them. However, the opinions of these groups differ when it comes to satisfaction with the amount of progress that has been made. Many environmentalists continue to pursue a goal of zero chemical discharge, while industry is satisfied with the results so far. With the Clean Water Act up for renewal, debates rage on Capitol Hill. Environmentalists aim to restructure the act, toughening regulations. Many industrial organizations support renewal of the act, but resent more governmental controls.

U. of Alabama at Birmingham

Mary Hovinga—There are still a lot of PCBs in water.



US Chamber of Commerce

Charles Ingram—Restructuring the CWA with stricter controls is unwarranted.

"Our fundamental view is that the Clean Water Act has been very successful in reducing discharges from industrial sources, and we see continued improvement in water quality," said Karen Fidler, director for air and water issues at the Chemical Manufacturer's Association. "There is no need for the types of major restructuring being proposed in the Senate and the House right now."

Ingram agrees that the bills in the House and Senate are unwarranted, saying that industry complies with EPA's current regulations 90–92% of the time. Ingram says industry does support renewal of the act, calling it "one of the most effective environmental statutes that we have," but does not support any restructuring. What the act does need, he said, is some minor changes, such as more flexibility. In a press release, the CWIC says that incentives and the use of risk assessment and cost–benefit analysis would do more than burdensome requirements to achieve shared goals of environmental improvement.

Yet environmentalists want to update the act in order to reach its original goal of zero discharge. They agree that the act has been successful, but argue it has not achieved its full potential. Tougher policies would speed the process of water cleanup. "The law as currently written has been responsible for dramatic improvements in U.S. water quality," said Paul Schwartz, national campaigns co-director for Clean Water Action, "but EPA's report that 40% of America's lakes and rivers are not suitable for fishing and swimming shows that there is a lot more work to be done."

Because banning the production of DDT and PCBs was so effective in lowering the levels of these toxins in water, environmentalists now want to phase-out other chemicals, such as chlorine. President Clinton has developed a national strategy to evaluate the environmental and health impacts of chlorine. Based on the results of this study, the EPA would develop a plan for appropriate action to reduce, substitute, or eliminate the use of chlorine and chlorinated compounds. The Chlorine Zero Discharge Act, which calls for a phase-out of the use of chlorine, has been introduced by Congressmen Bill Richardson (D-New Mexico) and Henry Waxman (D-California). The act aims to eliminate the discharge of dioxin, a chlorinated organic compound, created when chlorine is heated or burned. Dioxin, discharged in large amounts by pulp and paper manufacturers, is extremely toxic. Chlorine and chlorinated organic compounds including dioxin have been found to persist in the environment for long periods of time and have been linked to reproductive problems and cancers including those of the bladder, rectum, and breast. "As more information comes to light about these chemicals, we need to be looking at ways to reduce exposure, in the interest of public health," Roberts said. Roberts cited that alternative methods to chlorine use in manufacturing have been discovered, and she, like other environmentalists, hopes that a ban would push industry to turn to these methods.

Industry does not support solutions such as phase-outs of chemicals to improve water quality. "We are adamantly opposed to any phase-out or chlorine amendment," Ingram said. The CWIC is concerned about the Clinton strategy and the bill that would implement a phase-out. In a press release, the CWIC cited the benefits of chlorine for consumers and the economy and opposed a ban, saying, "the Clean Water Act more appropriately deals with the release of chemical substances—not their use."

The future of water quality will depend on the outcomes of these debates, how much industries are willing to do to continue to decrease toxic emissions, what citizens will do to decrease nonpoint-source pollution, and what the government will require. Today's water pollution problems may not be as visible as the burning rivers of the 1960s, but the fiery debate underlying America's water quality continues to rage.

Brandy E. Fisher

Brandy Fisher is a writing intern in the Environmental Toxicology Program at the NIEHS.